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TEMPERATURE AND DENSITY ALTITUDE CONSIDERATIONS
FOR DESIGN OF ARMY HELICOPTERS

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TEMPERATURE AND DENSITY ALTITUDE CONSIDERATIONS FOR DESIGN OF ARMY HELICOPTERS

1. BACKGROUND

THE BASIC DESIGN CRITERIA FOR THE DEVELOPMENT OF ARMY HELICOPTERS REQUIRE THAT AIRCRAFT BE CAPABLE OF HOVERING OUT OF GROUND EFFECT AT AN ALTITUDE OF 6,000 FEET WHEN THE TEMPERATURE IS 95°F. THIS REQUIREMENT, COMMONLY REFERRED TO AS THE ARMY HOT DAY REQUIREMENT, IS MORE SEVERE THAN THE CRITERIA IN USE FOR AIR FORCE AND NAVY AIRCRAFT, AND HAS BEEN QUESTIONED BY AUTHORITIES FAMILIAR WITH HELICOPTER OPERATIONS. THE 6,000 FOOT DESIGN TEMPERATURE OF THE AIR FORCE AND NAVY IS 81°F, REQUIRING AN AIR FRAME WEIGHT APPROXIMATELY ONE-HALF THAT NECESSARY TO MEET THE ARMY STANDARD.

THE FREQUENCY OF OCCURRENCE OF HIGH TEMPERATURES AT ELEVATIONS UP TO 6,500 FEET IN THE WARMER LATITUDES IS PRESENTED IN THIS STUDY IN ORDER THAT THE CURRENT ARMY HOVERING CEILING REQUIREMENT CAN BE EVALUATED. ()

2. PRESNTATION OF DATA

A. ALTITUDE DELIMITATION

BEFORE THE CURRENT ARMY HOT DAY REQUIREMENT WAS ADOPTED, APPARENTLY AN ALTITUDE REQUIREMENT OF 6,000 FEET WAS ESTABLISHED FOR HELICOPTERS HOVERING OUT OF GROUND EFFECT. WITH THIS CEILING LIMIT IN MIND FIGURE 1 WAS PREPARED TO SHOW THE GLOBAL DISTRIBUTION OF HIGHLANDS IN TWO CLASSES. THE "MODERATELY HIGH" AREAS IN BLACK (BETWEEN 1,000 AND 2,000 METERS OR 3,280 AND 6,560 FEET) ARE OF PRIME INTEREST SINCE THEY ARE THE AREAS OF HIGHEST ALTITUDES AT WHICH HELICOPTERS CURRENTLY ARE EXPECTED TO OPERATE UNDER ALL TEMPERATURE CONDITIONS. SINCE HIGH TEMPERATURES ARE NOT AS FREQUENT AT HIGH LATITUDES, THE STUDY WAS LIMITED TO AN ANALYSIS OF TEMPERATURE REGIMES BETWEEN LATITUDES 15°N AND 45°S AT "MODERATELY HIGH" ALTITUDES. FROM THE MAP IT CAN BE SEEN THAT "MODERATELY HIGH" AREAS ARE MOST EXTENSIVE IN SOUTHERN ASIA, SOUTHERN AFRICA, AND WESTERN UNITED STATES AND MEXICO. THEY ARE NOT EXTENSIVE IN AUSTRALIA AND SOUTH AMERICA OR IN EUROPE SOUTH OF 45°N.

B. TEMPERATURE REGIMES DURING WARMEST MONTH

TEMPERATURE MEASUREMENTS THROUGHOUT THE WORLD ARE GENERALLY MADE UNDER "STANDARD" CONDITIONS IN INSTRUMENT SHELTERS AT HEIGHTS RANGING FROM ABOUT FOUR TO EIGHT FEET. DURING THE WARMER PERIOD OF THE DAY TEMPERATURE DIFFERENCES BETWEEN THE "STANDARD" LEVEL AND THE HEIGHT OF GROUND EFFECT ON HOVERING HELICOPTERS (ABOUT 10 TO 20 FEET WITH CURRENT ROTOR LENGTHS) ARE SMALL. IT IS THEREFORE POSSIBLE TO APPLY "STANDARD" MEASUREMENTS TO THE HELICOPTER DESIGN REQUIREMENT PROBLEM.

THE PERCENTAGE OF TIME DURING THE WARMEST MONTH THAT "STANDARD" TEMPERATURES WERE ABOVE 80°, 85°, 90°, 95°, 100°, AND 105°F WAS DETERMINED FOR A NUMBER OF STATIONS IN THE "MODERATELY HIGH" AREAS OF THE WORLD. AT THE MAJORITY OF STATIONS THESE PERCENTAGE FREQUENCIES WERE ESTIMATED FROM CONSIDERATION OF THE AVERAGE TEMPERATURE AND THE AVERAGE DAILY RANGE OF TEMPERATURE DURING THE WARMEST MONTH USING A TECHNIQUE DEVELOPED BY SPREEN.* ACTUAL PERCENTAGE FREQUENCIES WERE AVAILABLE FOR UNITED STATES STATIONS AND A FEW STATIONS THROUGHOUT THE WORLD. ALL FREQUENCY DATA ARE PRESENTED IN TABLE 1 ALONG WITH MEAN DAILY MAXIMUM AND ABSOLUTE MAXIMUM TEMPERATURES OF THE WARMEST MONTH.

TIME DID NOT ALLOW FOR ESTIMATION OF FREQUENCY OF HIGH TEMPERATURES FOR ALL MONTHS. THE ANNUAL FREQUENCY OF OCCURRENCE OF TEMPERATURES ABOVE THE GIVEN LEVELS, HOWEVER, CAN BE ROUGHLY ESTIMATED BY MULTIPLYING THE PERCENTAGE FREQUENCIES IN TABLE 1 BY THE FOLLOWING FACTORS:

STATION LATITUDE	0° - 20°				20° - 45°				
	PERCENTAGE OF TIME EXCEEDED				PERCENTAGE OF TIME EXCEEDED				
TEMPERATURE (°F)	80	85	90	95	80	85	90	95	100
FACTOR	.55	.50	.38	.25	.35	.31	.28	.21	.15

THESE FACTORS WERE DETERMINED EMPIRICALLY FROM ANALYSIS OF TEMPERATURE FREQUENCIES AT TEN STATIONS DURING ALL MONTHS. A FACTOR AS LOW AS .08 WOULD INDICATE THAT TEMPERATURES ABOVE THE GIVEN VALUE USUALLY OCCUR DURING THE WARMEST MONTH WHILE A FACTOR OF 1.0 WOULD INDICATE THAT TEMPERATURES ABOVE THE GIVEN VALUE PROBABLY OCCUR IN EVERY MONTH. IT CAN BE SEEN THAT HIGH TEMPERATURES ARE NOT RESTRICTED TO ONE MONTH. AT LOW LATITUDE STATIONS TEMPERATURES ABOVE 80°F MAY OCCUR EQUALLY AS OFTEN IN AS MANY AS SIX MONTHS. IN THE HIGHER LATITUDES, HOWEVER, TEMPERATURES ABOVE 95°F OR 100°F NORMALLY OCCUR ONLY IN THE TWO OR THREE WARMEST MONTHS.

C. DENSITY ALTITUDE

THE DENSITY ALTITUDES THAT WERE EXCEEDED FIVE PERCENT OF THE TIME IN THE WARMEST MONTH, IS PRESENTED IN THE FINAL COLUMN OF TABLE 1. THESE FIGURES WERE ALSO USED IN THE PREPARATION OF FIGURE 2 WHICH IS A SCATTER DIAGRAM OF DENSITY ALTITUDE VERSUS STATION ALTITUDE.

DENSITY ALTITUDE REFERS TO A THEORETICAL DENSITY WHICH WOULD EXIST IN A STANDARD ATMOSPHERE AT A GIVEN HEIGHT. THIS STANDARD ATMOSPHERE HAS

*SPREEN, WILLIAM C. EMPIRICALLY DETERMINED DISTRIBUTIONS OF HOURLY TEMPERATURES JOURNAL OF METEOROLOGY, VOLUME 13, AUGUST 1956, WASHINGTON, D.C.

A PRESSURE OF 29.92" OF HG AND A TEMPERATURE OF 59°F AT SEA LEVEL. THE ASSUMED TEMPERATURE LAPSE RATE IS 3.56°F PER THOUSAND FEET; THUS IN THIS STANDARD ATMOSPHERE, AT AN ELEVATION OF 2,000 FEET, THE TEMPERATURE WOULD BE ABOUT 7°F LOWER THAN THE SEA LEVEL TEMPERATURE. WHEN TEMPERATURES ARE HIGHER THAN THE "STANDARD" TEMPERATURE THE DENSITY OF THE AIR WILL BE LESS AND WILL BE EQUAL TO THE AIR DENSITY AT SOME HIGHER ALTITUDE WHERE THE "STANDARD" TEMPERATURE PREVAILS. THIS THEORETICAL HIGHER ALTITUDE IS CALLED THE DENSITY ALTITUDE.

THE DENSITY ALTITUDE AT EACH STATION WAS COMPUTED BY FIRST ESTIMATING THE TEMPERATURE WHICH IS EXCEEDED FIVE PERCENT OF THE TIME IN THE WARMEST MONTH (FROM TABLE 1) AND THEN COMPUTING THE DENSITY ALTITUDE FROM A CHART WHICH PRESENTS DENSITY ALTITUDE AS A FUNCTION OF TEMPERATURE AND ALTITUDE (FIGURE 3 - THE CHART WAS ENLARGED FROM TM 1-260, PRINCIPLES OF ROTARY WING FLIGHT, SEPTEMBER 1957). THE DENSITY ALTITUDES SO DERIVED ARE ONLY APPROXIMATIONS BECAUSE HUMIDITY AND PRESSURE VARIATIONS FROM NORMAL WERE NOT CONSIDERED AND BECAUSE THE "FIVE PERCENT" TEMPERATURES WERE ESTIMATES. WIND ALSO WAS NOT CONSIDERED ALTHOUGH IT HAS A DEFINITE EFFECT ON HOVERING CEILINGS. WHEN TEMPERATURES ARE HIGH THERE IS USUALLY SOME AIR MOVEMENT AND THE HOVERING CEILING IS RAISED.

3. DISCUSSION OF DATA

FROM FIGURE 1 IT CAN BE SEEN THAT A SUBSTANTIAL PERCENTAGE OF THE LAND BETWEEN 45°N AND 45°S CAN BE CLASSED AS HIGHLANDS AND IS POTENTIALLY A CHALLENGE TO HELICOPTER OPERATIONS. OF COURSE NOT ONLY THE AMOUNT OF SUCH LANDS BUT ITS DISTRIBUTION IN STRATEGIC AREAS OF THE WORLD IS SIGNIFICANT.

HIGH TEMPERATURES AT MODERATE ELEVATIONS OCCUR MOST FREQUENTLY IN THE SOUTHERN PORTIONS OF ASIA AND NORTH AMERICA. KERMAN, IRAN, ALTITUDE 6,100 FEET, HAS TEMPERATURES ABOVE 95°F 18 PERCENT OF THE TIME IN JULY AND THE AVERAGE DAILY MAXIMUM DURING THAT MONTH IS 101°F; KABUL, THE CAPITAL OF AFGHANISTAN, AT 5,895 FEET, HAS A MEAN DAILY MAXIMUM IN JULY OF 92°F AND TEMPERATURES ARE ABOVE 95°F SIX PERCENT OF THE TIME. THE TEMPERATURE REGIMES AT THESE STATIONS ARE EXTREME BUT ARE INDICATIVE OF THE OCCURRENCE OF APPRECIABLE AREAS OF HIGH HOT LANDS IN SOUTHWEST ASIA. IF MORE CLIMATIC DATA WERE AVAILABLE FROM THIS REGION THERE WOULD UNDOUBTEDLY BE MANY MORE REPORTS OF SIMILAR HOT CONDITIONS AT MODERATE ELEVATION.

IN NORTH AMERICA TEMPERATURES AT MODERATE ELEVATIONS ARE MOST EXTREME IN CENTRAL MEXICO WHERE CAMARGO, 5,423 FEET, HAS A JUNE MEAN DAILY MAXIMUM OF 108°F AND TEMPERATURES CAN BE EXPECTED TO BE ABOVE 95°F NEARLY A QUARTER OF THE MONTH. IN THE SAME AREA, LAGOS, 6,138 FEET, HAS TEMPERATURES ABOVE 95°F ELEVEN PERCENT OF THE TIME IN AN AVERAGE JUNE. TEMPERATURES ARE GENERALLY NOT AS HIGH AT THESE ELEVATIONS IN THE UNITED

STATES; NEVERTHELESS, MEAN DAILY MAXIMUM TEMPERATURES ABOVE 80°F OCCUR AT ALTITUDES UP TO 6,500 FEET AND TEMPERATURES ABOVE 95°F OCCUR AT ALL STATIONS IN TABLE 1 EXCEPT ELY, NEVADA. MORE DETAILED INFORMATION ON THE OCCURRENCE OF HIGH TEMPERATURES AT HIGH ALTITUDES IN THE UNITED STATES IS PRESENTED IN RESEARCH REPORT EA-9 "HIGH TEMPERATURES AT HIGH ELEVATIONS", QUARTERMASTER RESEARCH & ENGINEERING COMMAND, NATICK, MASSACHUSETTS, JANUARY 1958.

IN FIGURE 2 IT CAN BE SEEN THAT AT ANY GIVEN ALTITUDE IN TROPICAL AND TEMPERATE LOCATIONS THE DENSITY ALTITUDE DURING THE WARMEST MONTH VARIES BY ABOUT 2,000 FEET FROM THE COOLEST TO THE WARMEST STATIONS, AND THE DENSITY ALTITUDE IS MORE A FUNCTION OF ALTITUDE THAN IT IS OF TEMPERATURE. TEMPERATURES ARE AN IMPORTANT DETERMINANT OF DENSITY ALTITUDE, BUT THE DETERMINATION OF THE ALTITUDE CEILING AT WHICH HELICOPTERS SHOULD BE EXPECTED TO HOVER IS THE MOST IMPORTANT ASPECT OF THE HELICOPTER DESIGN REQUIREMENT PROBLEM.

THE BLUE LINE IN FIGURE 2 IS THE DENSITY ALTITUDE OF THE "ARMY HOT DAY REQUIREMENT". THE RED LINE IN THE FIGURE IS THE DENSITY ALTITUDE OF THE AIR FORCE-NAVY "HOT ATMOSPHERE". THE RELATIVE MERITS OF THE TWO STANDARDS CAN ONLY BE DETERMINED WHEN THE REQUIRED CEILING HEIGHT AND THE AMOUNT OF RISK TO BE ALLOWED ARE DETERMINED. THE GEOGRAPHICAL DATA IN THIS REPORT WILL ASSIST IN THE DETERMINATION OF THE RELATIVE MERITS OF THE TWO STANDARDS.

TABLE 1: FREQUENCY OF OCCURRENCE OF HIGH TEMPERATURES
DURING WARMEST MONTH AT STATIONS AT MODERATE ELEVATIONS

STATION	LATITUDE	LONGITUDE	ALTITUDE	TEMPERATURE DURING WARMEST MONTH (°F)			DENSITY EXCEEDED 5% OF TIME	ALTITUDE EXCEEDED 5% OF TIME
				MEAN DAILY MAX	ABSOLUTE MAX	% OF TIME EXCEEDED		
NORTH AMERICA								
<u>MEXICO</u>								
COAHUILA	25°47'N	103°07'W	3,625	96	108	42	27	6,200 FEET
VILLA GONZALES	30 38	106 31	3,953	97	109	50	31	7,550
NAZAS	25 13	104 07	4,183	99	111	52	43	8,300
SALTILLO	25 26	101 00	5,479	82	100	15	5	8,550
CAHARDO	27 42	105 10	5,423	108	120	66	50	9,750
LAGOS	21 21	101 55	6,138	97	109	41	29	10,250
AGUASCALIENTES	21 53	102 18	6,224	82	99	27	15	9,700
BUSTILLOS	28 28	106 39	6,526	90	99	29	19	10,200
<u>UNITED STATES</u>								
AMARILLO	35 14	101 42	3,604	92	106	40	26	6,600
EL PASO	31 48	106 24	3,916	94	105	44	26	7,600
SALT LAKE CITY	40 46	111 58	4,240	91	101	38	24	7,500
RENO	39 39	119 47	4,400	92	104	32	20	7,600
POCATELLO	42 55	112 32	4,466	90	101	30	17	7,650
GRAND JUNCTION	39 06	108 32	4,839	92	100	39	25	8,200
WINSLOW	35 01	110 44	4,833	93	104	39	26	8,250
WILFORD	38 25	113 01	5,033	92	103	40	28	8,500
ELKO	40 50	115 47	5,079	80	104	32	21	8,400
CASPER	42 55	106 20	5,290	86	103	25	14	8,400
ALBUQUERQUE	35 03	106 37	5,314	92	101	38	24	8,700
DENVER	39 46	104 53	5,332	87	103	26	14	8,550
ELY	39 17	114 51	6,557	86	92	23	12	9,750

TABLE 1 (CONT.)

STATION	LATITUDE	LONGITUDE	ALTITUDE	TEMPERATURES DURING WARMEST MONTH (°F)				DENSITY ALTITUDE						
				MEAN DAILY MAX	ABSOLUTE MAX	% OF TIME EXCEEDED	80	85	90	95	100	105		
<u>EUROPE</u>														
<u>SPAIN</u>														
GRANADA	37°11' N	3°47' W	2,198	90	104	31	17	6	1	*				
SORIA	41°30'	2°00'	3,471	80	106	13	5	2	1	*				
AVILA	40°30'	4°35'	3,694	80	100	13	4	1	*					
<u>PORTUGAL</u>														
MONTALEGRE	41°50'	7°50'	3,369	74	96	5	2	1	*					
SERRA DA ESTRALLA	40°05'	4°54'	4,547	70	90	2	1	*						
<u>AUSTRALIA</u>														
ALICE SPRINGS	23°37' S	133°55' W	1,926	25	116	54	32	24	7	3	1			
K. ANDRA	35°33'	148°31'	4,640	69	91	3								
<u>AFRICA</u>														
<u>SOUTH AFRICA</u>														
QUEENSTOWN	31°54' S	26°52' E	3,533	86	105	23	12	5	1	*				
KINDERLY	28°56'	24°46'	3,935	91	107	36	20	7	3	1				
CARNARVON	30°58'	22°08'	4,112	90	101	31	20	10	2	*				
FRASERBURG	31°55'	21°31'	4,150	87	104	24	15	6	1	*				
SUTHERLAND	32°25'	20°42'	4,776	81	96	20	11	5	1	-				
LINDLEY	27°53'	27°55'	5,000	85	99	23	11	4	1	-				
JOHANNESBURG	26°11'	28°03'	5,750	80	92	12	3	*	-					
HARRIS SMITH	28°16'	29°10'	5,900	76	95	8	2	*	-					
QACHASNEK	30°07'	28°42'	6,469	77	95	9	4	*						

5,100
6,000
6,300

5,500
6,700

5,500
6,900

5,500
6,950

5,500
6,800

5,500
6,950

TABLE I (CONT.)

STATION	LATITUDE	LONGITUDE	ALTITUDE	TEMPERATURES DURING WARMEST MONTH (°F)				DENSITY ALTITUDE EXCEEDED 5% OF TIME						
				MEAN DAILY MAX	ABSOLUTE MAX	% OF TIME EXCEEDED	80	85	90	95	100	105		
AFRICA (CONT.)														
SOUTHWEST AFRICA AND BACHUANALAND														
BETHANIEN	26°30'S	17°10'E	3,085	103	115	58	44	30	20	7	4			
KHOMO	21 00	24 30	3,501	95	107	48	30	15	6	1	*			
GANZI	21 30	21 45	3,710	92	100	44	27	9	2	*	-			
GUIBES	26 44	16 54	4,291	91	101	36	22	10	3	*	-			
WINDHOEK	22 34	17 06	5,666	86	95	24	10	1	*	-	-			
THE RHODESIAS AND MOMAMBIQUE														
VICTORIA FALLS	17 56	25 50	3,034	96	106	51	33	18	9	3	*			
LIVINGSTONE	17 50	25 49	3,090	96	109	53	33	19	8	2	*			
SPUNGABERA	20 28	32 46	3,445	81	102	51	40	23	*	-	-			
KUNGU	15 17	23 05	3,488	99	109	58	40	23	13	6	-			
CHIPINGA	20 12	32 38	3,694	80	98	52	41	21	*	-	-			
FORT ROSEBERY	11 11	28 53	3,830	94	104	42	27	16	7	*	-			
NYINILUNGA	11 45	24 26	4,450	85	96	46	28	14	5	*	-			
NPIKA	11 51	31 27	4,647	85	93	22	9	2	*	-	-			
SALISBURY	17 50	31 01	4,331	80	99	23	14	6	1	*	-			
MELSETTER	19 47	32 51	4,370	85	96	12	6	1	*	-	-			
ABERCORN	08 49	31 23	4,407	77	97	13	4	1	*	-	-			
INYANGA	18 13	32 44	5,514	77	91	9	3	*	-	-	-			
MOUNT NUZA	18 43	32 49	6,668	68	82	-	-	-	-	-	-			

TABLE I (CONT.)

STATION	LATITUDE	LONGITUDE	ALTITUDE	TEMPERATURES DURING WARMEST MONTH (°F)				DENSITY ALTITUDE % OF TIME EXCEEDED	DENSITY ALTITUDE EXCEEDED 5% OF TIME
				MEAN	ABSOLUTE MAX.	DAILY MAX.	MAX.		
<u>AFRICA (cont.)</u>									
TANGANYIKA, UGANDA, KENYA, SUDAN									
DODOMO	06°15'S	35°44'E	3,707	83	93	15	5	*	
ENTEBBE	00 04 N	32 29	3,878	80	98	13	6	*	
ARUA	03 01	30 55	4,200	88	103	16	19	7	1
LERUA	04 00	32 35	4,265	95	100	19	19	7	1
ARUSHA	03 21 S	36 42	4,630	85	99	12	4	1	
MBARARA	00 37	30 39	4,734	83	93	17	6	*	
MUBENDI	00 35 N	31 22	5,128	81	94	16	4	*	
NAIROBI	01 16 S	36 50	5,495	81	91	14	6	*	
MBEYA	08 52	33 27	6,000	79	87	7	*		
BR. SOMALILAND, ETHIOPIA, ERITREA									
UPPER SHEIKH	09 56 N	45 12	5,212	88	92	12	*		
CHENAFENA	14 18	39 01	5,351	91	95	13	7	*	
BONGA	07 13	36 17	5,658	85	88	20	3	*	
HARAR	09 19	42 09	6,071	80	90	10	1	*	
ADI UGRI	14 53	38 49	6,627	85	85	18	4	1	
ALGERIA, MOROCCO									
EL HAJEB	33 41	05 22	W	3,445	94	111	26	15	7
DJANET	24 25	09 25	E	3,609	100	111	67	33	18
IDELES	23 48	05 53	E	4,593	99	-	47	25	5
AXILAL	31 58	06 34	W	4,688	93	106	47	13	6
SEKRIT	32 10	04 50	W	6,266	87	100	26	15	7

TABLE I (CONT.)

STATION	LATITUDE	LONGITUDE	ALTITUDE	TEMPERATURES DURING WARMEST MONTH (°F)			DENSITY EXCEEDED 5% OF TIME	
				MEAN	ABSOLUTE MAX	% OF TIME EXCEEDED		
	DAILY MAX	MAX	80	85	90	95	100	105
AFRICA (CONT.)								
FRENCH EQUATORIAL AFRICA, FRENCH WEST AFRICA, ANGOLA								
N'GAOUNDERE	07°18' N	13°32' E	3,671	85	101	23	10	-
MALANJE	09 30 S	16 10	3,773	86	101	25	12	-
MALI	12 09 N	12 17 W	4,820	86	99	22	10	*
NUMBA FARM	11 50 S	15 00 E	5,413	77	82	2	-	-
				SOUTH AMERICA				
ARGENTINA								
ZAPALA	38 55	70 04 W	3,330	82	92	17	7	-
ANDALGALA	27 36	66 20	3,504	83	101	46	10	*
SALTA	24 47	65 25	3,878	83	95	16	3	-
MALARGUE	35 33	69 35	4,652	85	95	22	13	*
				PERU				
PERU								
MOQUEQUA	17 11	70 56	4,185	82	89	18	5	-
LA JOYA	16 44	71 51	5,351	79	83	5	1	-
EQUADOR								
HELL MERA	01 30	78 03	3,421	80	87	3	-	-
BANOS	01 24	78 23	6,002	73	87	2	-	-
				DENSITY EXCEEDED 5% OF TIME				
				6,400	7,250			
				6,650	7,800			
				7,800	7,800			
				5,900	6,900			
				6,600	7,800			
				5,550	6,400			

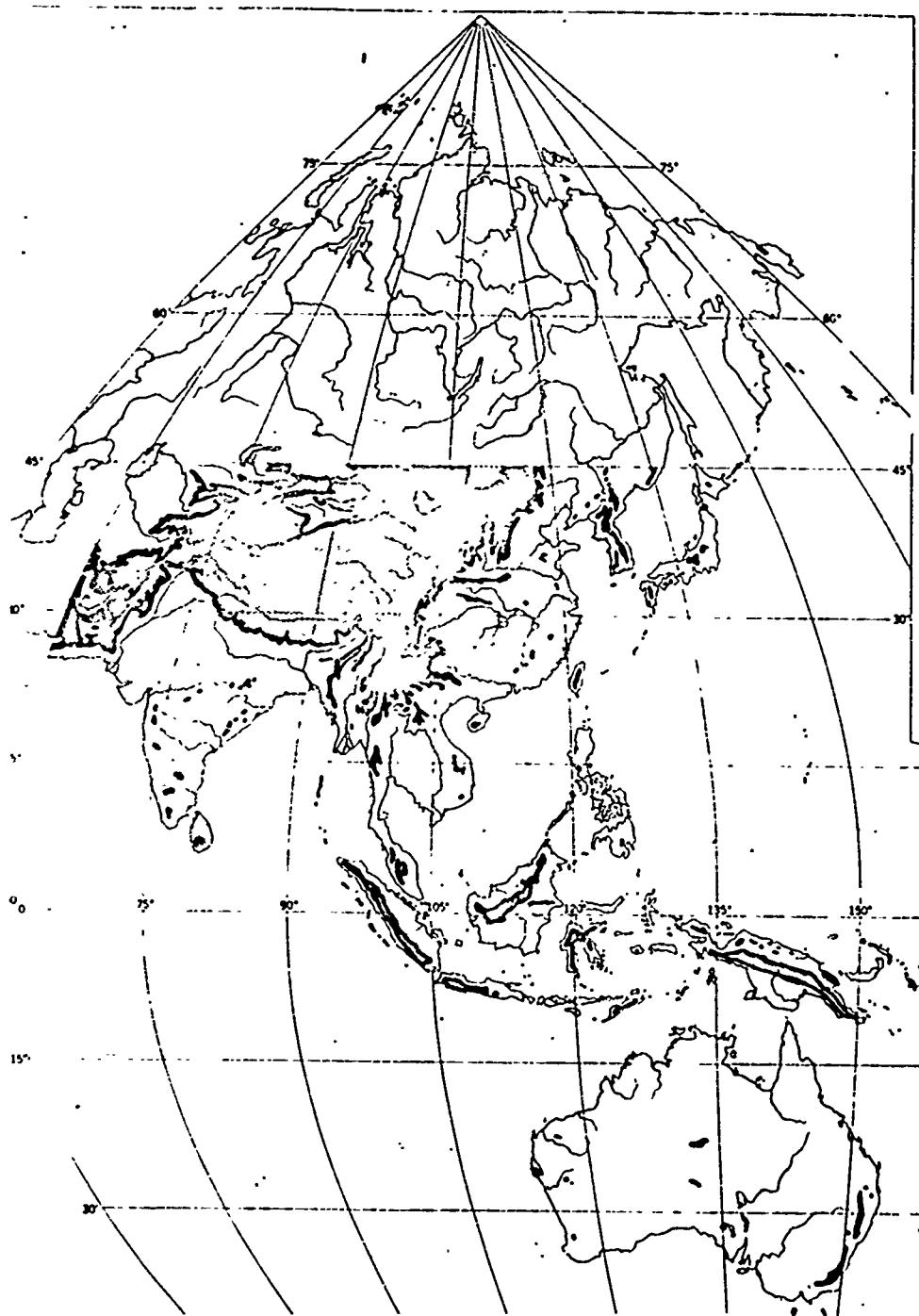
TABLE I. (CONT.)

STATION	LATITUDE	LONGITUDE	ALTITUDE	TEMPERATURES DURING WARMEST MONTH (°F)				DENSITY ALTITUDE EXCEEDED 5% OF TIME			
				MEAN	ABSOLUTE MAX	DAILY MAX	% OF TIME EXCEEDED	80	85	90	95
<u>SOUTH AMERICA (cont.)</u>											
BRAZIL	25°25'S	49°17'W	3,113	81	-	*	-	-	-	-	-
CURITIBA	25°25'S	49°17'W	3,113	81	-	*	-	-	-	-	-
<u>ASIA</u>											
<u>TURKEY</u>											
AFRON	38°45'N	35°18'E	3,300	85	92	98	25	14	6	2	-
ELAZIG	38°42'	39°15'	3,345	86	92	104	25	13	5	3	-
SIVAS	39°45'	37°00'	4,167	77	89	89	27	17	8	*	-
YONCAZ	39°50'	34°48'	4,345	80	91	91	3	7	*	-	-
KARS	40°36'	43°06'	5,740	78	80	14	7	6	*	-	-
KARS	40°36'	43°06'	6,155	81	81	15	7	1	*	-	-
ERZURUM	39°54'	41°16'	6,401	81	93	93	15	7	1	*	-
<u>SYRIA AND LEBANON</u>											
EL KAREYA	33°49'	35°40'	3,281	81	87	103	9	3	*	-	-
AL SUWAYDAH	32°50'	36°35'	3,609	72	72	79	27	13	5	*	-
LES CEDRES	34°16'	36°02'	6,332	72	-	-	-	-	-	-	-
<u>IRAN</u>											
TEHERAN	35°43'	51°23'	4,396	99	109	107	79	50	29	15	6
DOROUD	33°28'	49°03'	4,621	-	106	66	56	44	28	10	*
KERMANSHAH	34°19'	47°04'	4,860	97	106	50	32	20	10	4	*
HAMADAN	34°48'	48°30'	5,690	99	104	52	38	27	18	7	0
SULTANABAD	34°05'	49°39'	5,767	101	104	64	51	29	14	2	0
KERMAN	30°21'	47°05'	6,100	-	101	58	48	43	28	18	6

TABLE I (CONT.)

TABLE I (CONT.)

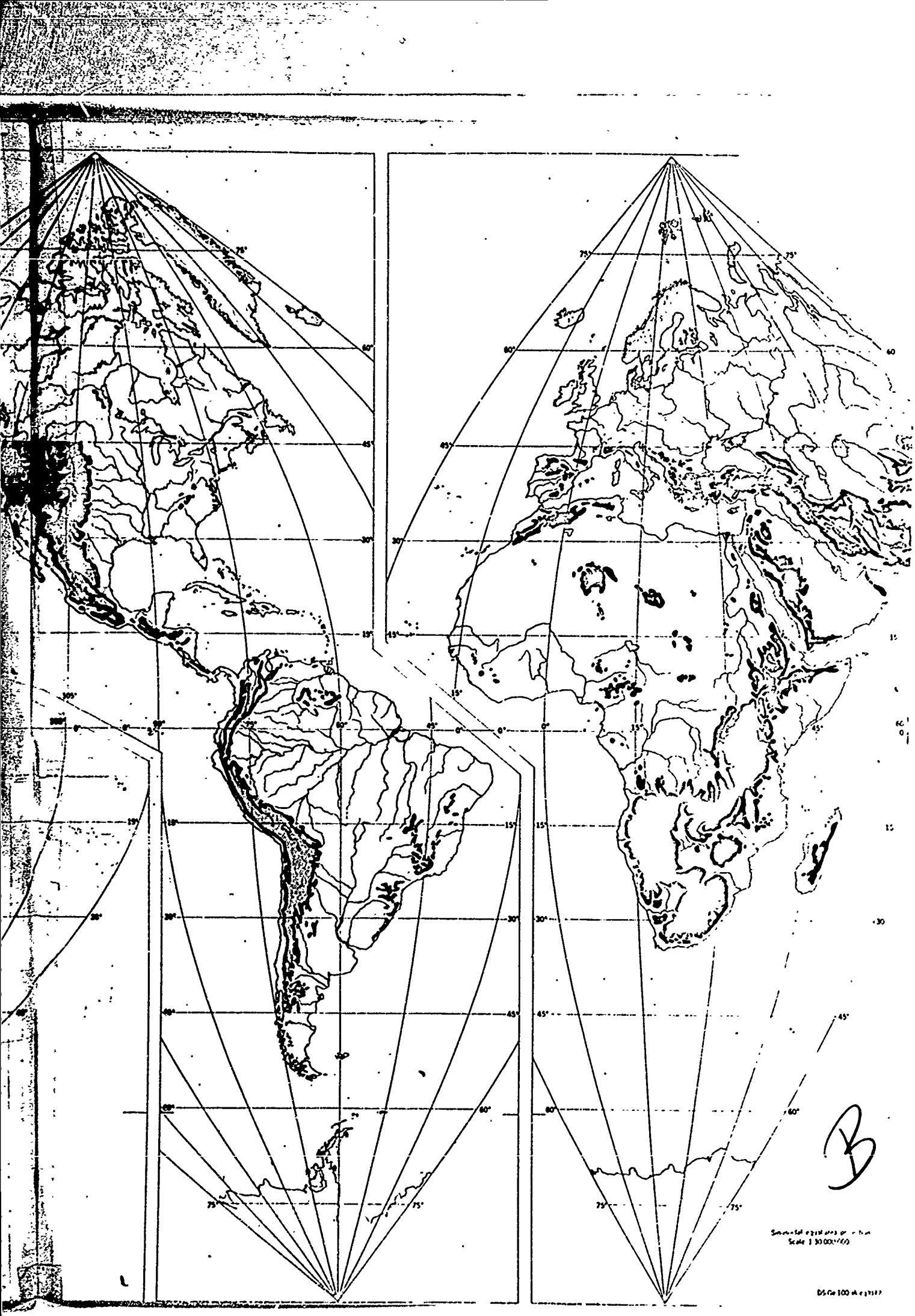
STATION	LATITUDE	LONGITUDE	ALTITUDE	TEMPERATURES DURING WARMEST MONTH (°F)				DENSITY EXCEEDED 5% OF TIME	ALTITUDE EXCEEDED 5% OF TIME
				MEAN	ABSOLUTE MAX	DAILY MAX	MAX		
ASIA (cont.)									
INDO-CHINA									
XIENG KHODANG	19°20' N	103°22' E	3,770	80	90	20	5	-	6,300
BOLOYEN	15 16	106 08	3,937	80	90	6	2	-	6,300
DALAT	11 57	103 26	4,921	80	88	12	6	-	7,700
CHA PA	22 22	103 52	5,381	74	84	2	-	-	7,600
CHINA AND KOREA									
KUEI-YANG	26 30	106 38	3,528	86	92	11	2	-	6,350
PUNGSAN	40 49	128 10	3,773	76	94	6	1	*	6,150
MENG-TZU	23 21	103 23	4,281	81	94	15	3	-	6,200
TENG CHUNG	25 02	98 28	5,360	75	83	2	-	-	7,650
PAO SHAN	25 05	99 10	5,491	75	87	4	2	-	7,900
KUN-MING	25 04	102 40	6,213	78	90	9	1	-	9,000
HSIANG-YUN	25 28	100 34	6,371	79	90	8	2	-	9,150
JAPAN AND PHILIPPINES									
HAKONE-YAMA	35 11	139 01	3,077	-	73	-	-	-	5,050
OCHIAI	35 48	138 49	3,687	-	-	-	-	-	5,900
ASO-ZAN	32 54	131 04	3,749	74	-	-	-	-	5,300
IBUKI-YAMA	35 25	136 24	4,514	69	-	-	-	-	6,600
BAGUIO	16 25	120 35	4,962	77	-	-	-	-	7,250
IWATE-YAMA	39 51	141 01	5,810	62	-	-	-	-	7,600

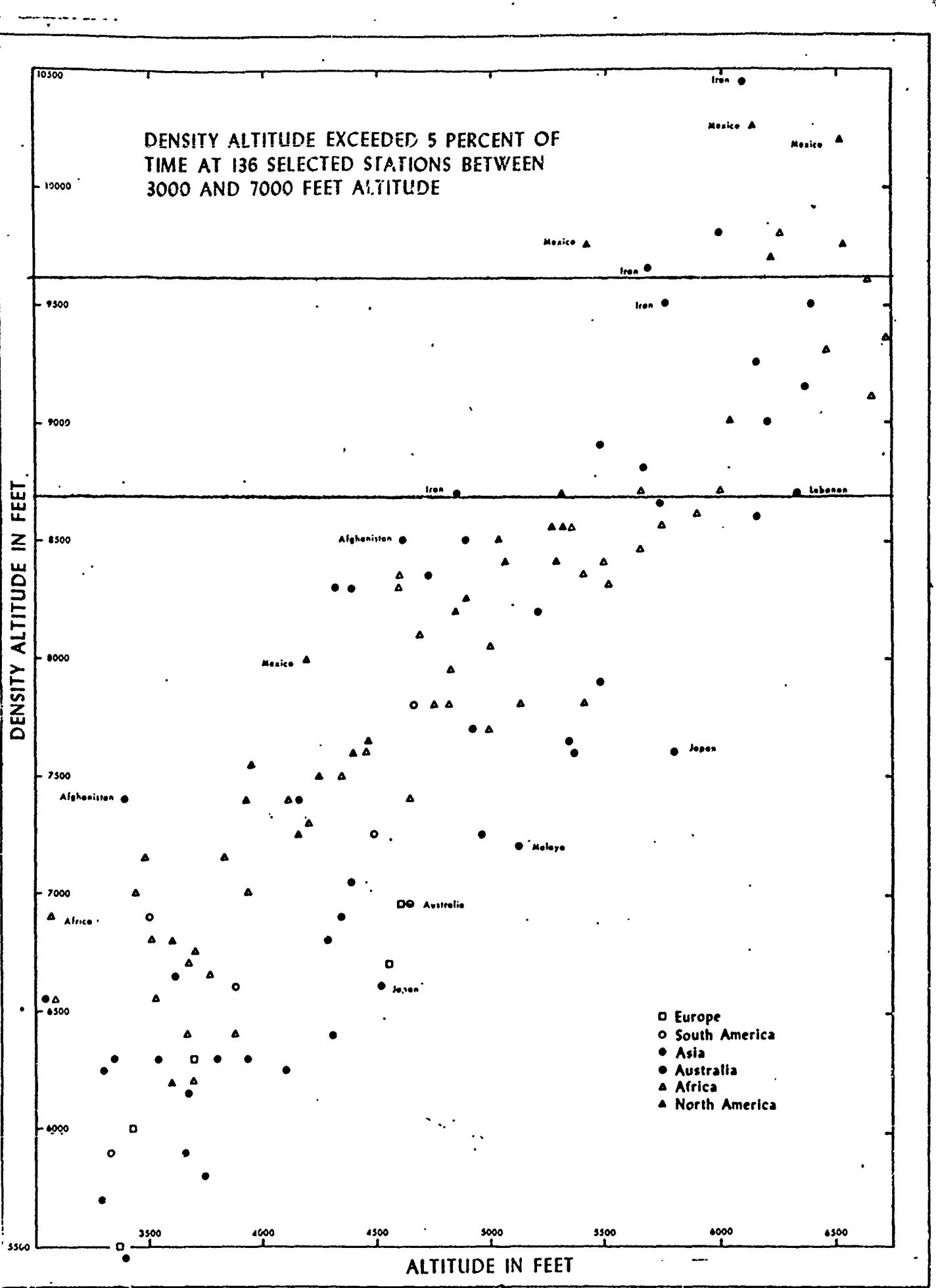


**DISTRIBUTION OF HIGH LANDS
BETWEEN 45°N 45°S**

High		Elevations above 2000 meters
Moderately High		Elevations between 1000 and 2000 meters
Low		Elevations below 1000 meters

Moderately high lands in areas of the world between 45°N and 45°S are considered for determining helicopter design criteria. Areas of greater elevation are too high for consideration and areas of lower elevation do not present as severe design problems.





SET ALTIMETER TO 29.92 IN. HG.
WHEN READING PRESSURE ALTITUDE

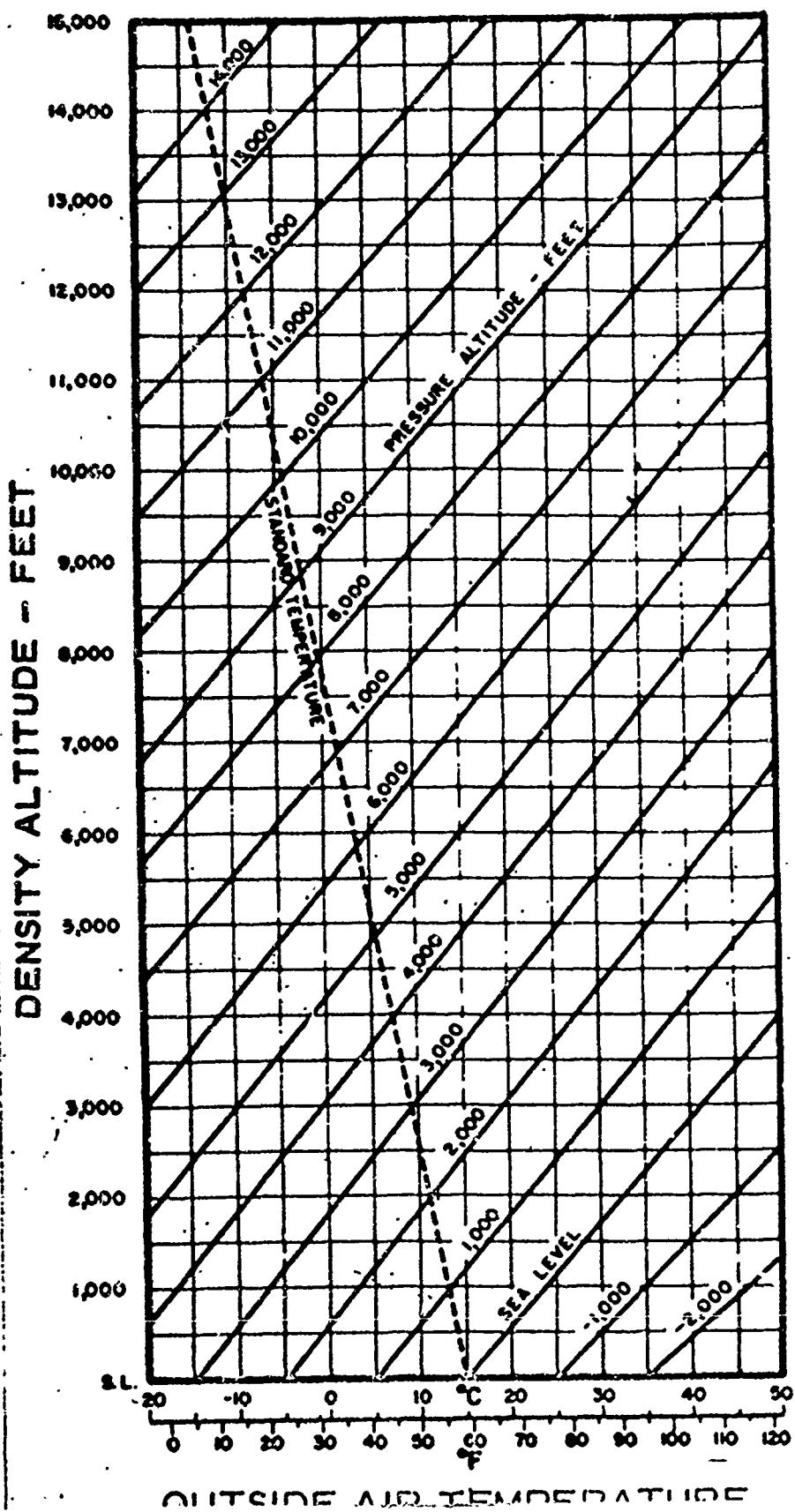


FIG 3